A Lesson from the past For Safer Future Tactical Vehicles

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ABSTRACT
Vehicle occupant safety is or at least should be the highest priority because of many lives, property and productivity lost every year to accidents. However in reality if there is no strong advocacy to watch and take action (commercial world) or due to mission requirements and special circumstances such as military operations, often safety falls by the way side. Accidents are generally caused because of the operator's inability to anticipate, see and plan for events during operation of the vehicle and/or by the physical surrounding he or she has to perform in.

The vehicle is a tool designed to perform functions necessary to safely take the occupants from one point to the other. A badly designed tool or an operator lacking experience in the use of the tool or both increase the possibility of an accident occurring.

Tactical vehicles have specialized mission profiles and often need to meet ever increasing demands for performance and utility. These vehicles are often modified by the users to meet their specialized mission needs without attention to possible safety concerns the change might create.

The US Army, National Automotive Center (NAC), safety thrust is to constantly be aware of the safety implications of tactical vehicle operation and the latest technologies applicable to these vehicle platforms to transfer such technologies to the user to make available safer vehicle systems while maintaining optimum performance and utility.

INTRODUCTION
There are 3 basic variables that may be put in the form of an equation representing vehicle occupant safety:

- Operator
- Hardware (The vehicle)
- Mission

And the basic equation may be shown as:

$$\text{Safety} = \frac{\text{Mission + Hardware}}{\text{Operator}}$$

The operator is the common denominator since it tries to accomplish a mission using the hardware (vehicle). This paper examines tactical vehicle, operator,

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **08 MAY 2003**	2. REPORT TYPE **N/A**	3. DATES COVERED
4. TITLE AND SUBTITLE **A Lesson from the past for Safer Future Tactical Vehicles**		5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) **Deylami /Ken**		5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **USATACOM 6501 E 11 Mile Road Warren, MI 48397-5008**		8. PERFORMING ORGANIZATION REPORT NUMBER **13871**
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) **TACOM TARDEC**		10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release, distribution unlimited.**		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**SAR**	**5**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

mission and hardware interfaces for their interrelation and effect on safety of operation. It also attempts to demonstrate existence of a relationship between the mission requirements and mishaps or injuries.

I will also recommend possible solutions.

Tactical vehicles are customarily designed to stay in the fleet for 20 to 25 years. However, mission necessary, hardware used throughout their active lives and associated technologies evolve at a faster rate than the vehicle design. This potentially creates unsafe conditions for the operator/occupant when such hardware is carried or operated inside the vehicle.

There is very little leg room in most tactical vehicle cabs. It is almost as though it is an unwritten rule that the soldier has to be uncomfortable or may be the mere fact of being in combat necessitates degradation of comfort level. Granted military vehicles are all about functionality but that should not mean uncomfortable, cramped quarters with potential safety hazards in the from of too many hard, sharp corners closer than what is considered safe in a collision or roll-over.

The soldier is given a mission to accomplish and to do that he or she does what gets the job done such as modifications to accommodate additional equipment with little or no regard for their safety implications.

In tactical vehicles the mission dictates hardware deployment inside the vehicle cab. Often vehicle designers have no idea what hardware is going to be used inside the vehicle several years in the future. It is also very unclear how s equipment dimensions will change as technology advances.

Need for communication between the vehicle crew, the command, and the unit levels all at different frequencies using multiple transmitters as well as the need for other navigation and night vision equipment has led to potentially hazardous vehicle cab environment. In an accident there will be a much higher chance of sever injury due to the occupants coming in contact with these hard and sharp objects (equipment) even if they are belted in.

Fig 1. See tray edges (Ref. 3)

Fig 2. Notice how much communication and navigation hardware is packed inside the cab (Ref. 3)

Fig 3. Notice how little room there is (Ref. 3)

Fig 4. Notice the location of the keyboard relative to the soldier's chest (Ref. 3)

In a paper on comparison of lap/shoulder belt vs. lap/shoulder plus supplemental shoulder belt restraint (Ref. 4), the authors describe "The mishap data identified that head injuries were the most frequent sever injury in all mishap categories. Although injury mechanisms could not always be identified from the database, the study of the mishap narratives, the in-depth investigation of 66 mishaps, a hazard analysis of several different HMMWV's, and injury mechanisms all combined to indicate that the vast majority of these head injuries resulted from head impact with interior vehicle surfaces.

Table 1 shows that roll-overs and side impacts combine to cause a disproportionately high number of fatalities.

Crash Mode	Fatalities	Percentage of all Fatalities
Front	23	39
Rollover	26	44
Rear	6	10
Side	4	7

Table 1

Naturally the more hardware is packed inside the vehicle the greater is the chance of the occupants coming in contact with it during a crash situation. This is because even with a restraint system some degree of excursion takes place particularly during side impacts and rollovers.

In this case the vehicle/hardware, the mission and the operator all are contributors to the resulting unsafe condition.

This clearly indicates that there is a need for a new approach to the problem and the answer lies in the vehicle and the hardware.

Tactical vehicles are designed to stay in service for 20 to 25 years. Chances are that more compact communication and navigation gear will be available sooner than newly design vehicles.

The reality is that the military needs to utilize the current fleet to its fullest potential. Also necessary hardware needs to be carried in these vehicles to accomplish the mission. The only alternative is to find ways to make the best of what is available to us

until such time that new hardware and/or vehicles are available.

This can be in the form of elimination of sharp edges, addition of padding to all unused surfaces in close proximity of the occupant body and the use of a more effective restraint system.

Adoption of innovative compact, secure communication technology by which the soldier is able to communicate with levels above and below will effectively eliminate the need for bulky communication gear. Like any technology the communication technology is advancing by the minute and the ideal battlefield communication gear may even be available as we speak, but getting it in the system and in the hands of the soldier is a lengthy process given the criticality and sensitivity of the military communication systems, the need for commonality and simply the existence of billions of dollars worth of systems and equipment currently in the inventory.

However the technology will advance regardless and eventually comes a time for more advanced, multifunction, compact communicators to be introduced into the system.

The same applies to the future tactical vehicles that the Army is currently developing. Now is a the time to consider and incorporate safety in the design and development of the Future Tactical Truck Systems (FTTS), for which the current emphasis seem to be on fuel economy, performance and survivability. Chances are that we most probably follow the same school of thought in system design, i.e. “does the system accomplish its intended mission per Operation Requirements Document ORD?”, and ignore the interface requirements of various systems that are not a part of the vehicle, but needed to accomplish the mission.

FTTS draft ORD (Ref. 2) lays out the “Emerging Desired Capabilities” and references crew restraint system requirements (page 6, line 188). Requirement for various safety technology should be included in the ORD, to insure the final product is designed with as many safety features as possible. Technologies such as collision warning (useful in low visibility and convoy operations), adaptive rear view mirror system (continuous blind-spot coverage), and roll-over threshold warning are a few to mention.

The U.S. Army has lost too many soldiers due to accidents in the latest operation in Iraq. This is a quote from the USA Today, date April 16, 2003, from an interview with General William Wallace commander of U.S. Army forces in Iraq (Ref. 2) “ Among the 121 U.S. military deaths from March 21 through Tuesday (April 15), 35 have been officially classified as accidents. Among the 31 British deaths, 16 have been classified as accidents”. Also “Of the 51 total accidental deaths, 28 were in helicopter crashes/collisions and 12 were in vehicle crashes. This war time statistic reinforces the need for safer vehicles, because vehicle accidents do happen so it is prudent to minimize the risk of death or injury by creating a safer vehicle interior as well as introduction of safety technology to prevent or minimize the risk of an accident occurring

Conclusion

Mission, hardware and the operator are the main contributors to safety. Consideration should be given to safety from the beginning in the process for tactical vehicle requirement generation. This requires improvement in communication among Product Management organizations so everyone's present and future requirements are included in the final product design.

Measures need to be taken to neutralize or minimize the safety hazards resulting from deployment of hardware inside the vehicle passenger compartment. Better restraint systems such as one with additional shoulder restraint or the Aviation type 4 point should be used to minimize excursion. Impact absorbing material should be added to all hard objects close to the occupant body will reduce chance of injury. Also for the future tactical vehicles, safety technology should be included as part of vehicle performance requirement.

REFERENCES

1. The following link is for the FTTS draft ORD. http://www.cascom.lee.army.mil/transportation/FTTS/Public/UVworkingcopy.pdf

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